Supporting Information

Artificial Photosynthesis of C1 to C3 Hydrocarbons from Water and CO_2 on Titanate Nanotubes Decorated with Nanoparticle Elemental Copper and CdS Quantum Dots

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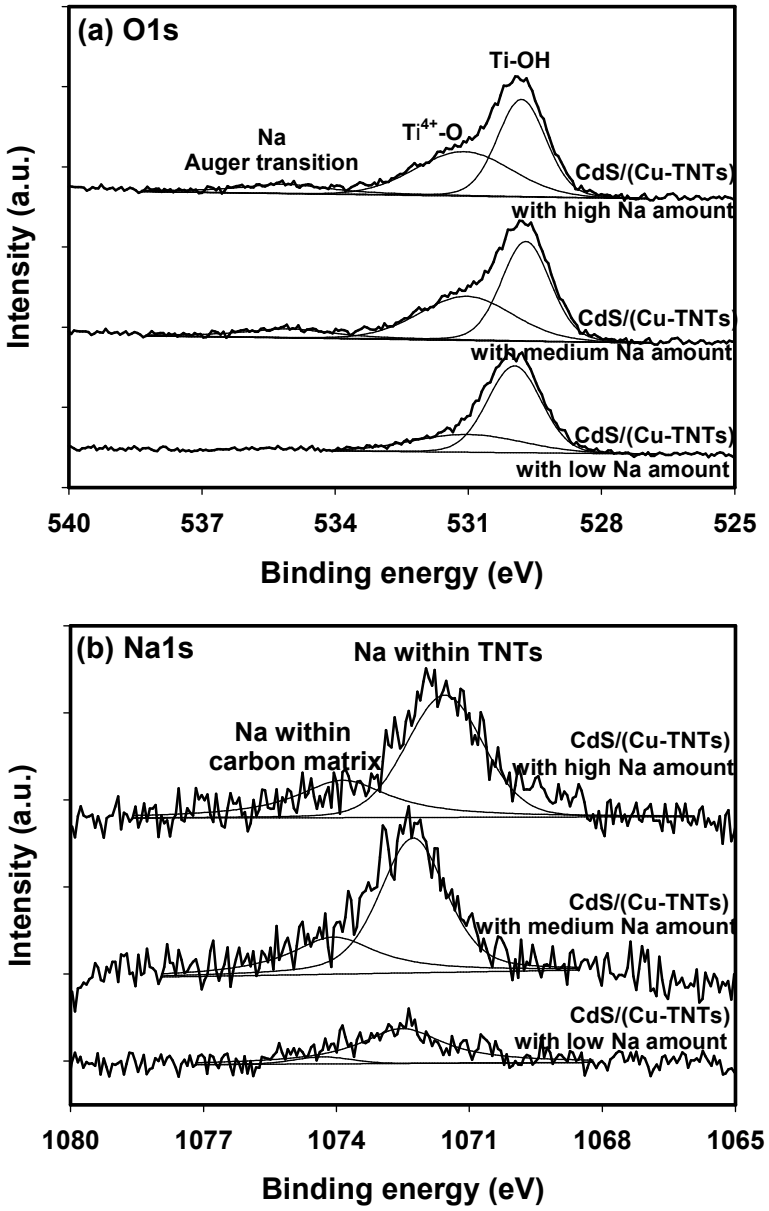

Figure S1. (a) O1s spectra of CdS/(Cu-TNTs) with three levels of intercalated Na amounts within TNTs (b) Na1s spectra of CO_2-preloaded CdS/(Cu-TNTs) in terms of the effect of intercalated amount of Na within TNTs.

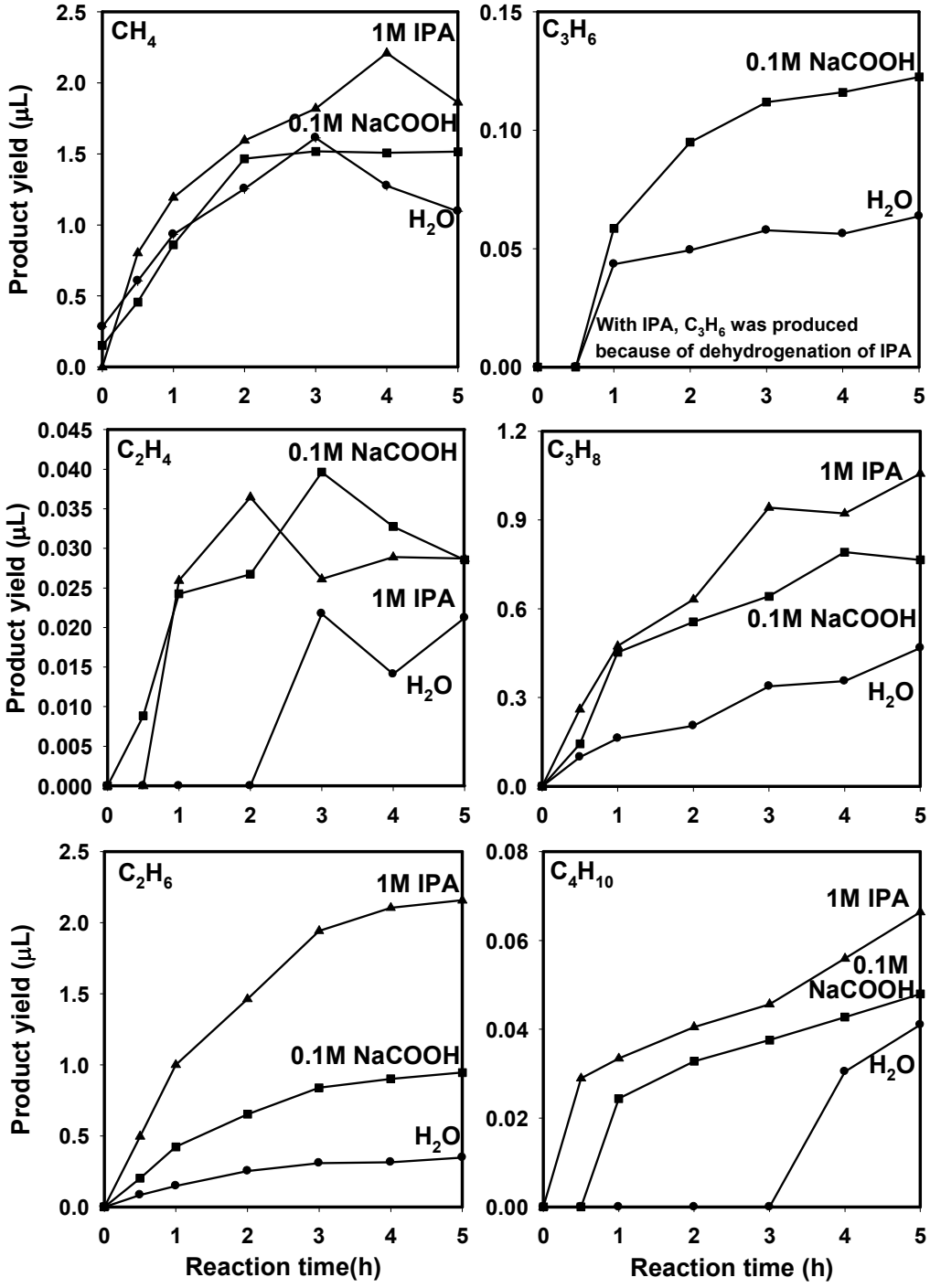

Figure S2. Effects of electron donors on time-profiled hydrocarbon formations on CdS/(Cu-TNTs) with low Na level.

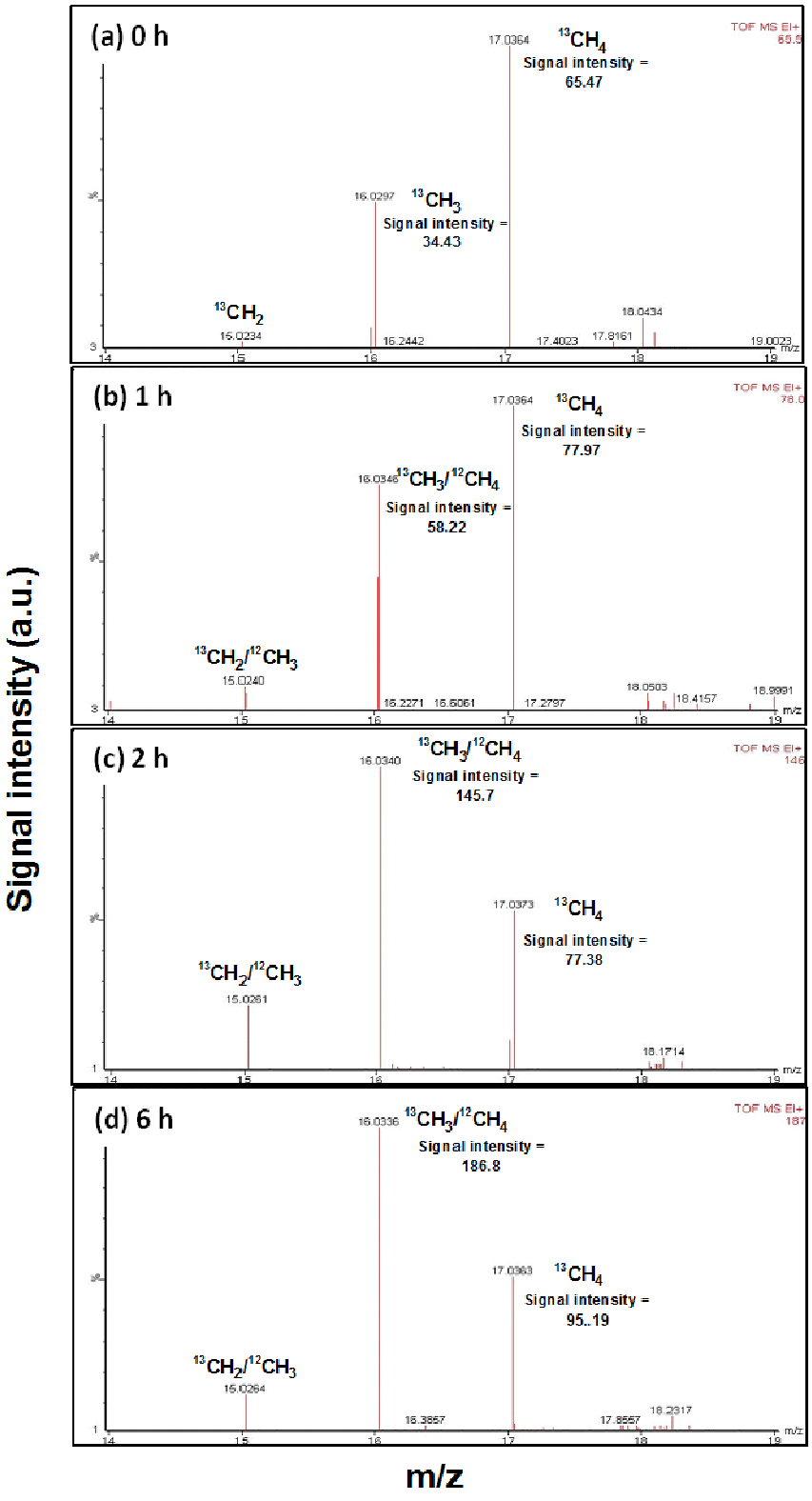

Figure S3. GC-MS spectra of methane produced during photocatalytic reduction of $^{13}CO_2$.

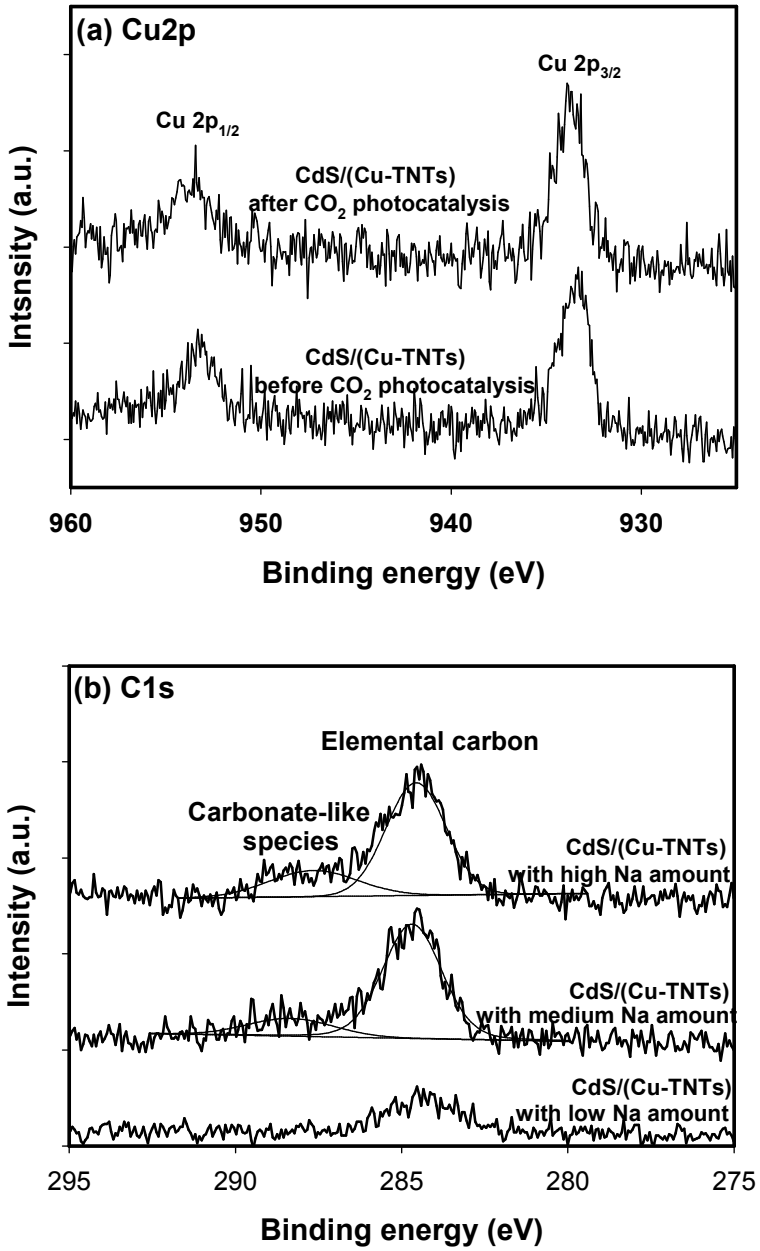

Figure S4. (a) XPS Cu 2p spectra before and after CO_2 photocatalysis for 4 hours. (b) C1s spectra of CO_2-preloaded CdS/(Cu-TNTs) in terms of the effect of intercalated amount of Na within TNTs.

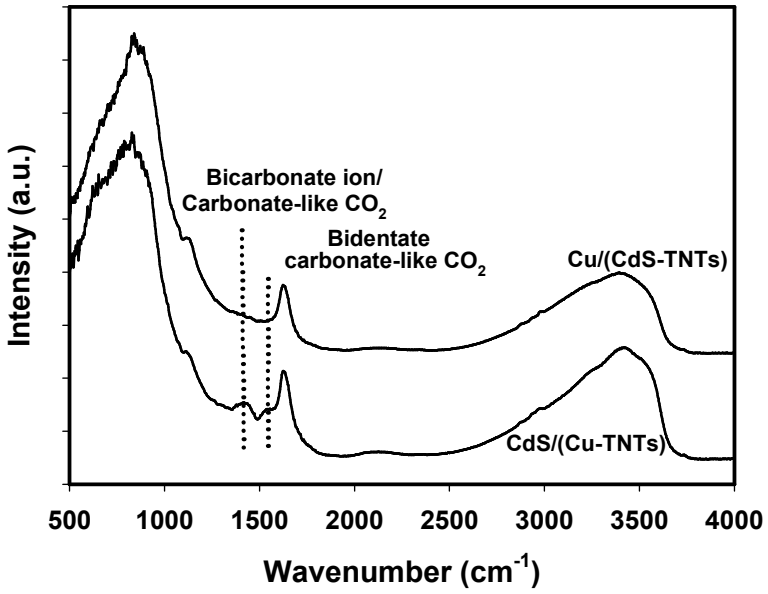

Figure S5. Comparison of FTIR spectra between CO_2-preloaded CdS/(Cu-TNTs) and Cu/(CdS-TNTs).

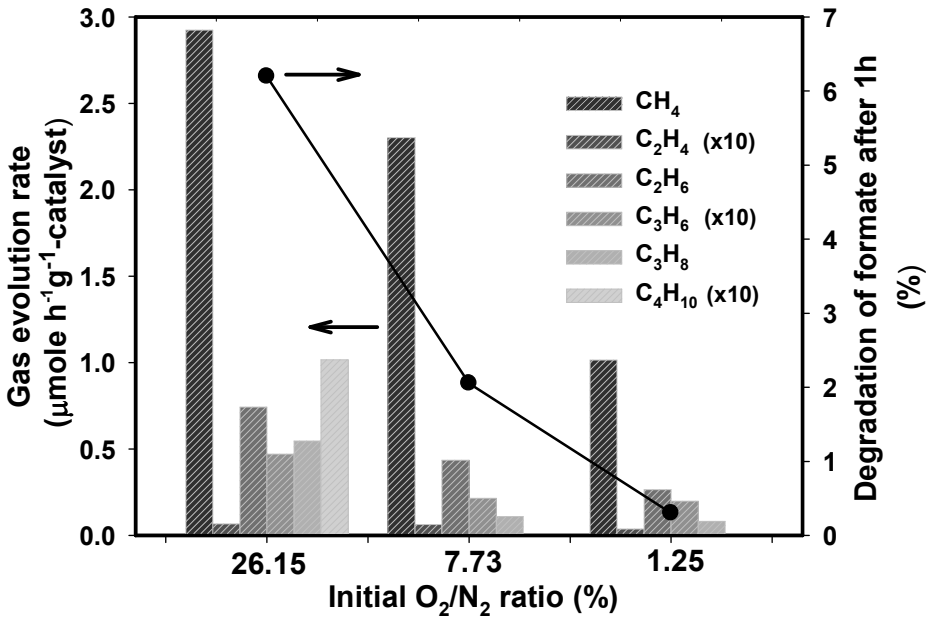

Figure S6. Photocatalytic conversion of formic acid into C1-C4 hydrocarbons on CdS/(Cu-TNTs) as a function of O_2/N_2 ratio. The gas evolution rate was calculated for 1 hour using 50 mg catalyst under visible light irradiation $\lambda > 420$ nm. The different initial O_2/N_2 ratios were achieved by purging Ar for different periods. The initial concentration of formate was around 200 μM and the pH of slurry remained 6.5 throughout the reaction time of interest (5 h-photocatalysis). The amounts of O_2 and N_2 were determined by the gas chromatograph/ thermal conductor detector equipped with a molecular sieve column using He as a carrier gas. Formate ($HCOO^-$) was analyzed by ion chromatography using a Dionex DX-500 ion chromatograph coupled with conductivity detection. Aliquots (0.5 mL) were injected, and anions were separated on an AS11-HC column (Dionex) and quantified by their conductivity measurements.